Insurance Design for Developing Countries

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Background

Being poor is risky

- e.g. exposure to agricultural, income, health and mortality shocks
- Approximately one third of dollar-a-day poverty is *transient* poverty

Exposure to risk leads to cautious behaviour...

- Avoid costly inputs, choose safe activities, etc.

...and cautious financial arrangements

- Keep unproductive liquid assets and small stocks
- Informal / semiformal mutual support

However, still exposed to covariate shocks

- Agricultural production shocks, large health shocks, etc.

An introduction to hedging in agriculture

Motivation:

- Agriculture is an uncertain business, particularly for the poor (Dercon 2004, Collins et al. 2009)
- Traditional indemnity-based approaches to crop insurance were unsustainable (Hazell 1992, Skees et al. 1999).
- Hedging products can be fairly cheap whilst still offering protection against key perils (Hess et al. 2005).

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Examples of hedging products currently being sold to poor farmers:

- Weather indexed insurance (rainfall, temperature, humidity, wind speed, etc.)
- Flood indexed insurance
- Area yield indexed insurance
- Remote sensing indexed insurance (NDVI, WRSI, etc.)
- Livestock index insurance

Thesis overview

Questions:

1. When ‘should’ consumers purchase a hedge against a potentially material loss?
2. Do Ethiopian farmers make ‘good’ decisions about hedging products?
3. What sort of insurance arrangements might be most appropriate for the poor?

Toolkit:

- Economic theory
  - Decision under uncertainty
  - Mechanism design
- Randomized experiments

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Two puzzles of weather derivatives for the poor

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2. Demand is particularly low for the most risk averse

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Key empirical papers include:

- Giné et al. (2008) India (AP): 5% uptake
- Giné and Yang (2008) Malawi: 13% fewer people take up loan with weather derivative than loan without
- Cole et al. (2009) India (AP and Gujarat): 5-10% buy product, hedging only 2-5% of household agricultural income

Two puzzles of weather derivatives for the poor

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Explanations include:

> *'Insurance purchase is sensitive to **price** [...] **credit constraints** [...] **trust**' (Cole et al. 2009)*

> *'The most likely explanation [for demand falling with risk aversion] is that it is **uncertainty** about the product itself (Is it reliable? How fast are pay-outs? How great is basis risk?) that drives down demand.' (Karlan and Morduch 2009)*

> *'Poor farmers on the other hand are not sufficiently well insured and would benefit from purchase of insurance, but they are severely **cash and credit constrained**.' (Binswanger-Mkhize 2011)*

Two puzzles of weather derivatives for the poor

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This paper can (partially) explain the puzzles as **objective, rational** responses to basis risk and actuarially unfair price:

- Basis risk:= the risk that the net income from the financial contract does not accurately reflect the incurred loss
- Actuarially unfair price:= $\mathbb{E}[\textit{Net transfer to insurer}] > 0$

Mathematical framework encompasses all (perceived) risk of contractual nonperformance, including trust, exclusions, insurer default, etc. (Doherty and Schlesinger 1990).

The 2×2 state model

- Initial background wealth w, exposed to loss of L
- Loss and index are imperfectly correlated with joint probability structure:

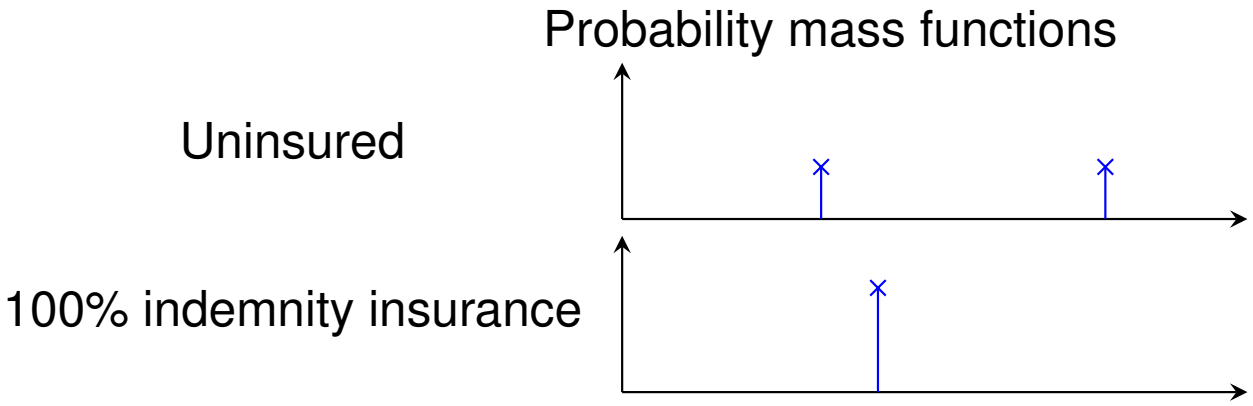
	$Index = 0$	$Index = I$	
$Loss = 0$	$1 - q - r$	$q + r - p$	$1 - p$
$Loss = L$	r	$p - r$	p
	$1 - q$	q	

- Basis risk, $r = \mathbb{P}[Loss = L \cap Index = 0]$
  - Positive basis risk: $r > 0$
  - Index and loss are affiliated: $r < p(1 - q)$
- Can purchase indexed cover of αL at premium multiple of m:
  - Premium of αqmL buys claim payment of αL if $Index = I$
- Consumer is strictly risk averse expected utility maximiser
  - Utility function u with $u' > 0$ and $u'' < 0$

What we talk about when we talk about insurance

Result without basis risk (Indemnity insurance, $r = 0$)	Result with basis risk (Indexed cover, $r > 0$)
Shape of rational hedging:	
• More risk averse $\Rightarrow$ buy more coverage	?
• Infinitely risk averse $\Rightarrow \alpha = 1$	?
• Fair price ($m = 1$) $\Rightarrow \alpha = 1$	?
• Positive loading ($m > 1$) $\Rightarrow$ buy less coverage	?
• Insurance is inferior for DARA utility	?
• Larger potential loss L $\Rightarrow$ buy more coverage for DARA utility	?
Level of rational hedging:	
• Positive loading ($m > 1$) $\Rightarrow$ any level of cover $\alpha \in [0, 1]$ is optimal for some strictly risk averse, DARA utility function u	?

Theorem 1: Infinitely risk averse consumer



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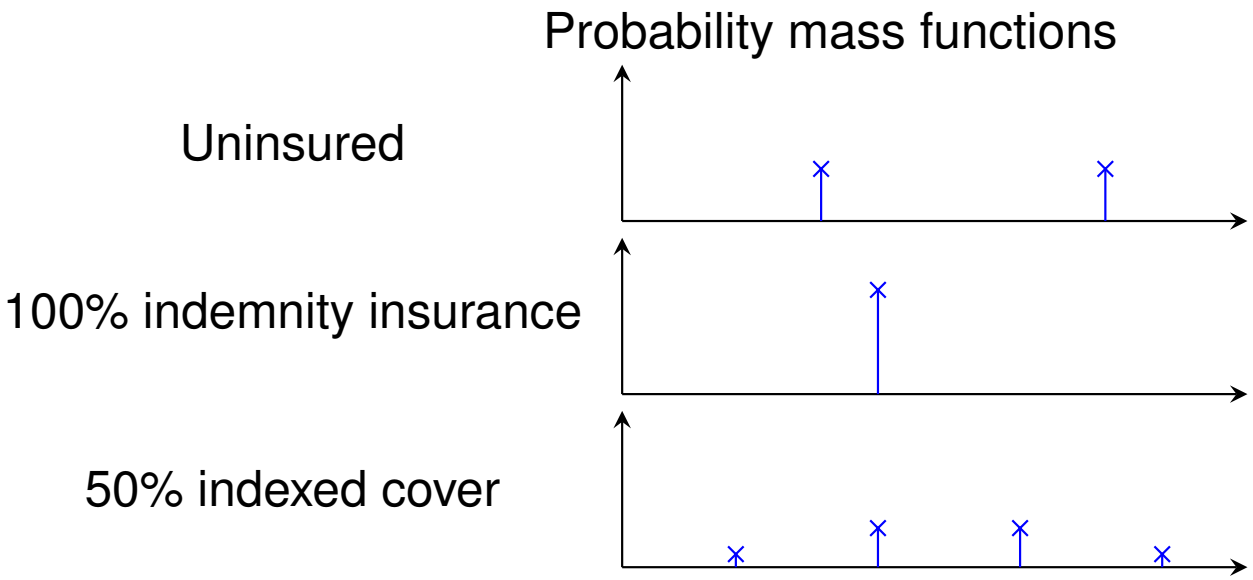

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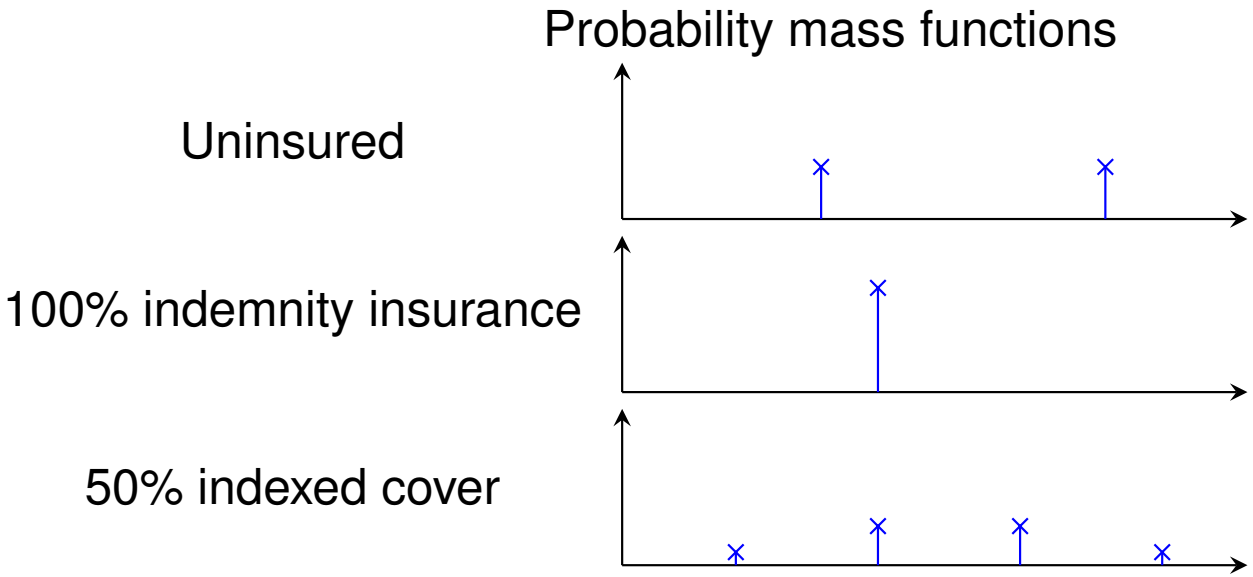


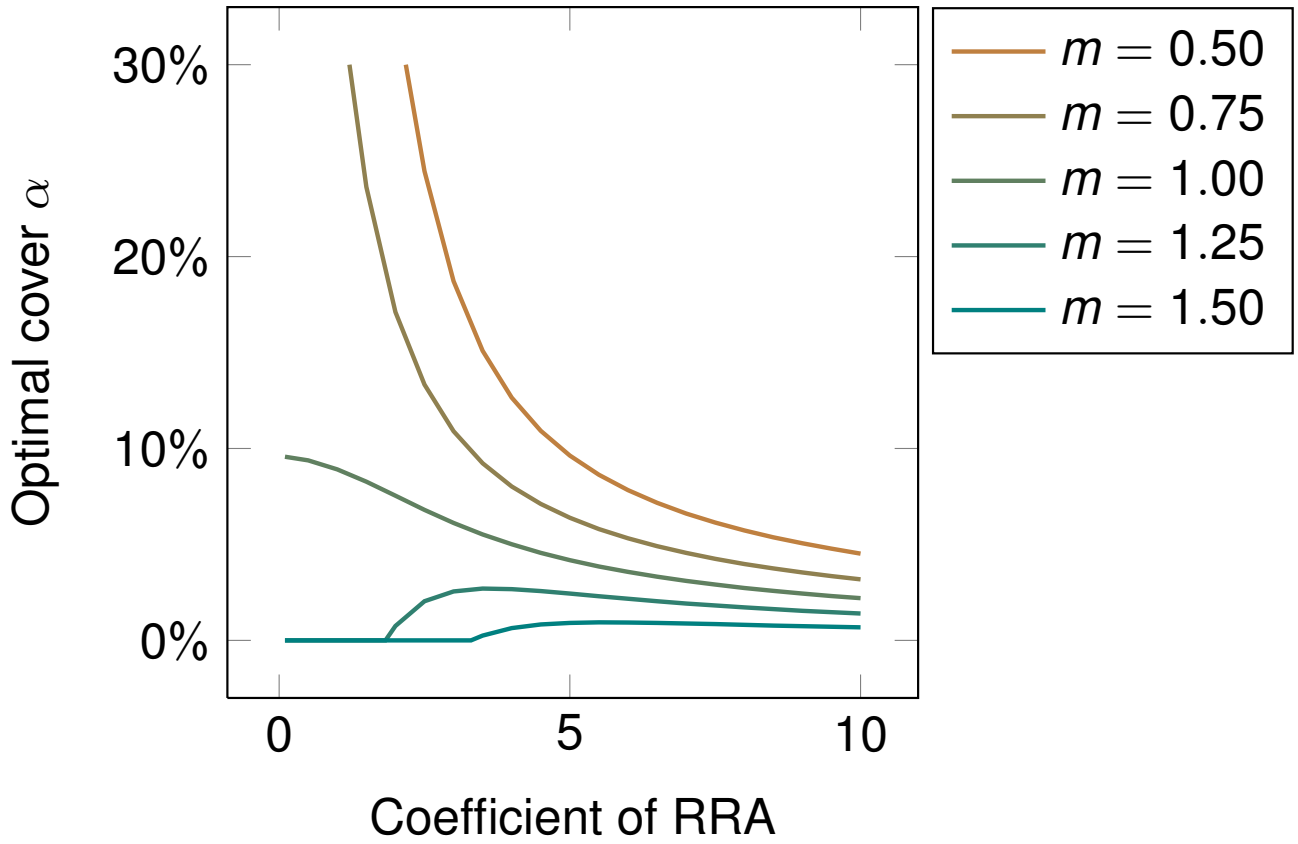
For an infinitely risk averse, maximin, consumer:

- Indemnity insurance ($r = 0$): $\alpha = 1$
- Indexed cover ($r > 0$): $\alpha = 0$

$\Rightarrow$ optimal purchase cannot be everywhere increasing in risk aversion.

Theorem 2: Changes in risk aversion

Optimal purchase of index insurance for maize in a developing country, from decision makers with CRRA utility function



Theorems 3 and 4: Bounds for rational demand

For the numerical example of maize in a developing country...

...no risk averse expected utility maximiser will optimally purchase *any* weather indexed insurance if $m > 1.751$. Cf.:

- Giné et al. (2007): Average premium multiple of 3.4
- Cole et al. (2009): Premium multiples of seven products, ranging from 1.7 to 5.3

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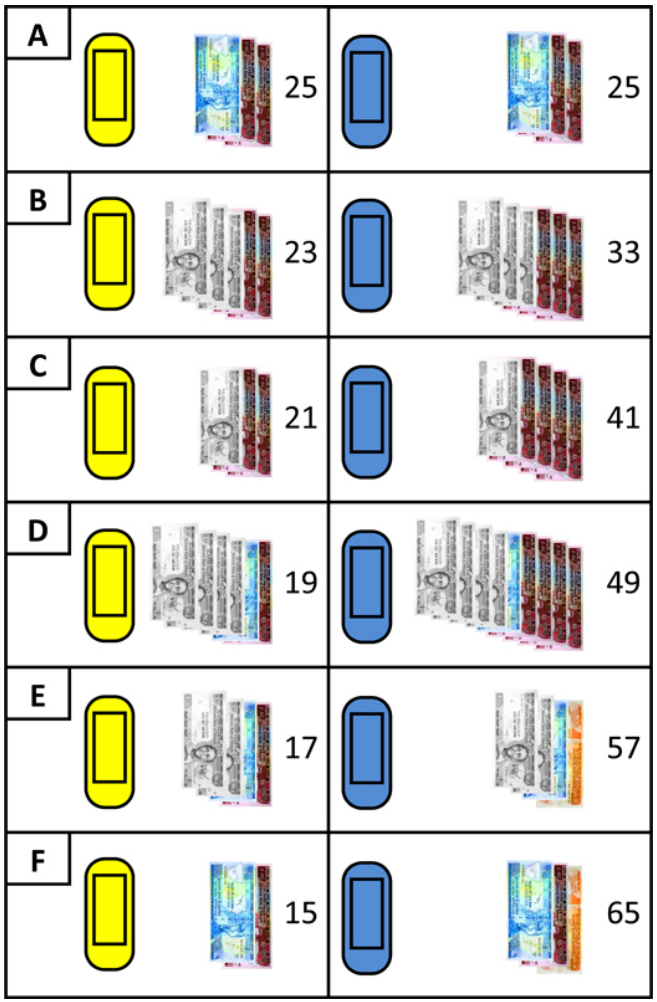
Lab experiment in Ethiopia

Benchmark: Binswanger lottery

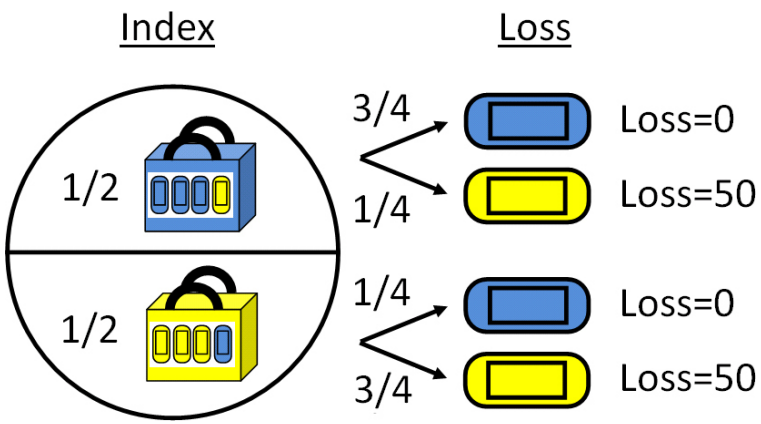


Index insurance decision problem

- Subjects start with (physical) endowment of 65 Birr
- But loss of 50 Birr with probability $\frac{1}{2}$
- Compound lottery (wheel spin + bag draw)

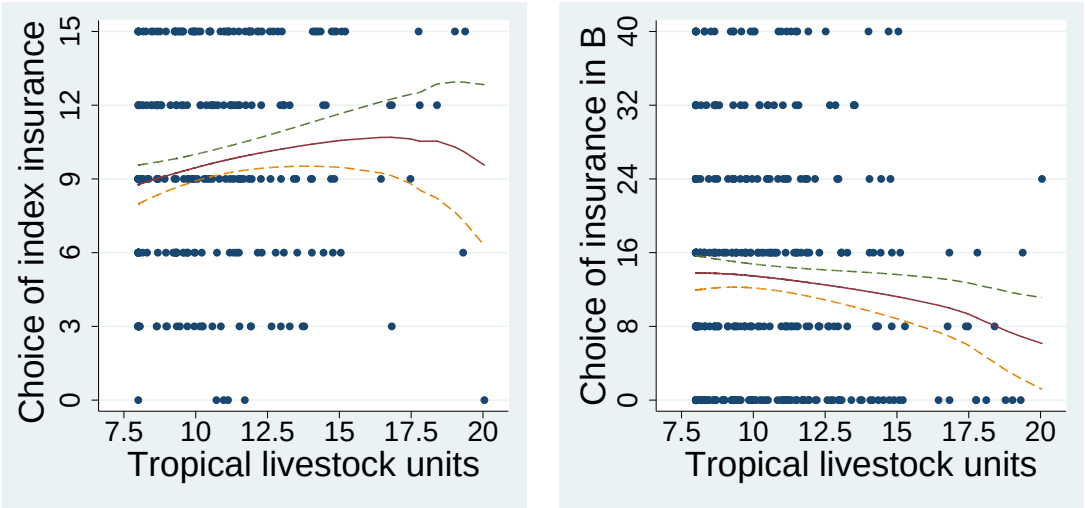
Can purchase between 0 and 5 units of index insurance

- One unit of insurance costs 3 Birr
- Claim payment of 5 Birr if the wheel selects the yellow bag



Scatter plot and kernel regression

Figure: Choice in decision problem against livestock owned

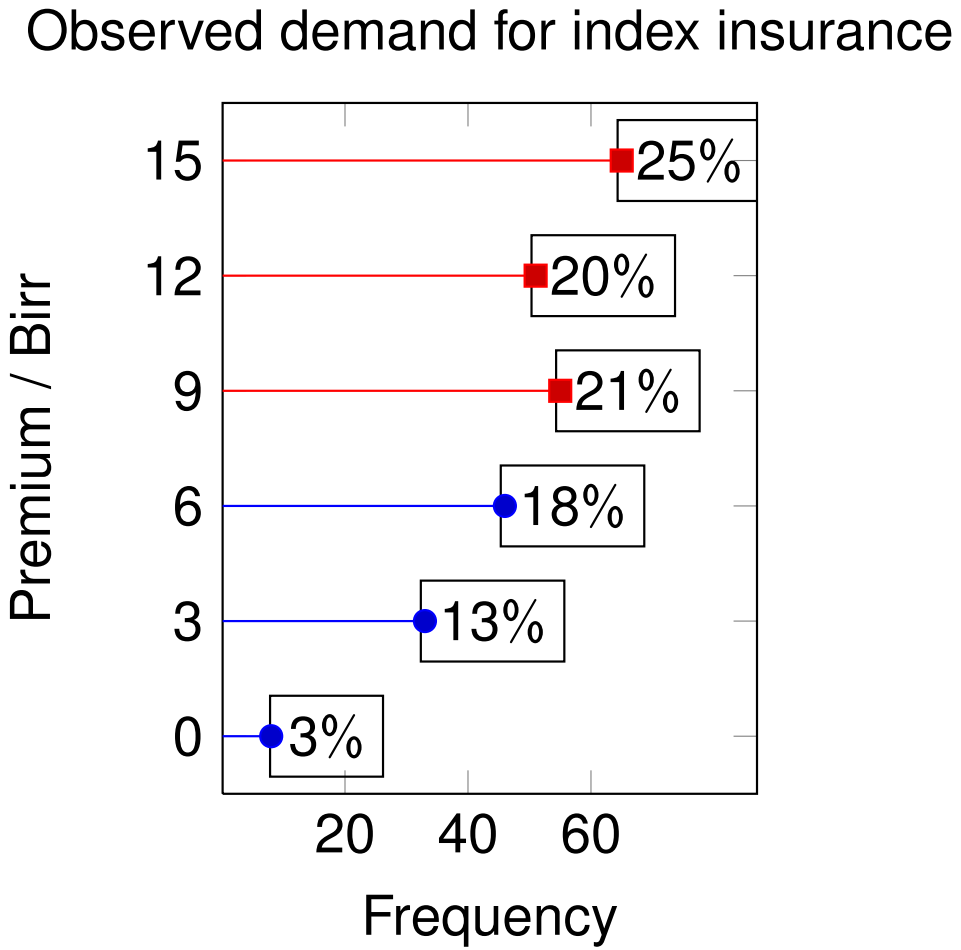


(a) Decision problem T_X (b) Decision problem B

The figures show the point estimate and 95% confidence intervals for an Epanechnikov kernel with a bandwidth of 0.8 and trimming of 0.05.

Observed demand for index insurance

- 171 out of 258 rural Ethiopian participants (66%) chose premiums above 6 Birr...
- ...but Theorem 4 (Chapter I) $\Rightarrow$ no risk averse DARA EUT maximisier would ever pay premium of more than 6 for index insurance.
- Evidence for 'irrationally high' not 'irrationally low' takeup



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A template for formal insurers

1. Think of role as that of reinsurer.
2. Contract with economically and socially contiguous groups:
   - Cheap loss adjustment technology
     $\Rightarrow$ cheap cross-reporting
   - Can sustain (at least partial) risk pooling
3. Use contracting power to support nonmarket insurance
4. Condition transfers on any cheaply observable indices / sample-based indices...
5. ... but also offer indemnity-based stop loss cover (gap insurance)

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Suggestions for future research

1. Economic theory
   - Optimal contracting
   - Welfare effects of subsidies
2. Field experiments
3. Laboratory experiments are well suited to normative questions
   - Do subjects make 'good' decisions about hedging products?
   - How effective is education / financial advice?
4. Operational issues for scaling up agricultural insurance
   - Design, pricing and risk financing for developing countries
     - cf. IAA and UK actuarial profession working parties
   - Analysis of basis risk in different contexts
   - Constructing objective financial advice
   - Improving area yield indexed insurance
5. Macroinsurance for the poor